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OXIDANT AND FUEL DISTRIBUTION FOR A FUEL CELL ASSEMBLY

BACKGROUND OF THE INVENTION

[0001] The present invention relates generally to fuel cell assemblies and, more particularly, to the oxidation and fuel distribution to fuel cells, such as solid oxide fuel cells.

[0002] A fuel cell is an energy conversion device that produces electricity by electrochemically combining a fuel and an oxidant across an ionic conducting layer. One typical construction of a high temperature fuel cell bundle is an array of axially elongated tubular shaped connected fuel cells and associated fuel and air distribution equipment. Other fuel cell constructions include planar fuel cells comprising flat single members. Exemplary planar fuel cells include counter-flow, cross-flow and parallel flow varieties. The members of a typical planar fuel cell comprise tri-layer anode/electrolyte/cathode components that conduct current from cell to cell and provide channels for gas flow into a cubic structure or stack.

[0003] Fuel cell stacks, such as solid oxide fuel cell stacks, have demonstrated a potential for high efficiency and low pollution in power generation. In a solid oxide fuel cell, upon electrochemically combining a fuel and an oxidant across an ionic conducting layer, an oxygen ion (0^{2-}) transported across the electrolyte produces a flow of electrons to an external load.

[0004] Oxidant, generally air, performs two main functions in the fuel cell stack. As discussed above, the oxidant electrochemically reacts with fuel to generate electric power. In addition, the oxidant is utilized to remove excess heat away from the cell. The waste heat generated in a solid oxide fuel cell at its operating temperature of about 600°C to about 1300°C is typically removed via the oxidant to maintain a desired temperature level of the fuel cell components, such as the anode, cathode and electrolyte.

[0005] For the stack to operate at maximum efficiency, all of the cells in the stack should operating at substantially the same operating temperature and have substantially the same reaction rate. In order to achieve this maximum efficiency, each cell requires about an equal amount of oxidant and fuel to be delivered.

[0006] Accordingly there is a need in the art to have an improved oxidant and fuel distribution system that can consistently deliver oxidant and fuel to the entire cell.

BRIEF SUMMARY OF THE INVENTION

[0007] An oxidant distribution system for a fuel cell assembly includes a fuel cell having at least one oxidant inlet and at least one oxidant outlet, a housing surrounding the fuel cell and an insulation layer positioned between the housing and the fuel cell. The insulation layer defines a cavity adjacent to the oxidant inlet for channeling oxidant flow to the oxidant inlet. A fuel distribution system for a fuel cell assembly including similar features is also disclosed.

[0008] These and other aspects, advantages, and salient features of the present invention will become apparent from the following detailed description, the accompanying drawings, and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a schematic illustration of an oxidant distribution system in accordance with one embodiment of the invention;

[0010] FIG 2 is a schematic illustration of a side view of an oxidant distribution system of FIG 1, in accordance with one embodiment of the invention;

[0011] FIG 3 is a schematic illustration of an oxidant distribution system in accordance with another embodiment of the invention;

[0012] FIG. 4 is a isometric view of a fuel cell;

[0013] FIG 5 is a schematic illustration of a side view of an oxidant distribution system of FIG. 3, in accordance with one embodiment of the invention; and

[0014] FIG 6 is a schematic illustration of a fuel distribution system in accordance with one embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0015] An oxidant distribution system 10 for a fuel cell assembly comprises a fuel cell 12, such as a solid oxide fuel cell, having at least one oxidant inlet 14 and at least one oxidant outlet 16, as shown in FIG. 1 and FIG. 2. A housing 18 surrounds the fuel cell 12 and bounds an insulation layer 20 that is positioned between the housing 18 and the fuel cell 12. Typically, insulation layer 20 comprises a rigid refractory material, such as a ceramic.

[0016] The insulation layer 20 defines at least a first cavity 22 adjacent to the at least one oxidant inlet 14 for channeling oxidant flow to the at least one oxidant inlet 14 from an oxidant supply feed 24.

[0017] In one embodiment, first cavity 22 is shaped such that a portion of first cavity 22 adjacent to the oxidant supply feed 24 substantially mates with said supply feed 24 and a second portion of first cavity 22 adjacent to the oxidant inlet 14 substantially mates with the oxidant inlet 14. Accordingly, the insulation layer 20 abuts or comes up adjacent to the oxidant supply feed 24 and abuts or comes up adjacent to the oxidant inlet 14, thereby defining first cavity 22. Typically, the cross-section of first cavity 22 at the oxidant inlet 14 is greater than the cross-sectional size of the first cavity 22 at the oxidant supply feed 24 thereby creating a diffuser effect that distributes oxidant more uniformly to the oxidant inlet 14 of the fuel cell 12. In one embodiment of the invention, an internal surface 26 of first cavity 22 is roughened 28 to enhance turbulent flow therethrough.

[0018] Oxidant distribution system 10 further comprises a second cavity 30 defined by insulation layer 20 adjacent to the at least one oxidant outlet 16 for channeling oxidant flow from the oxidant outlet 16 to an oxidant exit port 32. The second cavity 30 is shaped such that a first portion of the second cavity 30 adjacent to the oxidant exit port 32 substantially mates with said exit port 32 and a second portion of said second cavity 30 adjacent to the oxidant outlet 16 substantially mates with the oxidant outlet 16 so as to

channel oxidant flow from said fuel cell 12. In one embodiment, the cross-sectional size of said first portion of the second cavity 30 is greater than the cross-sectional size of the second portion thereby creating a reducer effect as the oxidant exits the oxidant outlet 16 of said fuel cell 12.

[0019] The advantages of this oxidant distribution system 10 are numerous. By using the insulation layer 20 as the oxidant distributor, the system has an overall reduction in the number of parts required. Additionally, by eliminating an additional air distributor, more insulation can be packed into a given housing 18 improving the overall efficiency of the system. Moreover, the use of the insulating layer 20 as the oxidant supply flow path also allows the oxidant leaving the first cavity 22 to retain more of its heat and creates efficiency advantages in certain system configurations.

[0020] Another embodiment of an oxidant distribution system 100 for a fuel cell assembly comprises a fuel cell 112, such as a solid oxide fuel cell, having an array of oxidant inlets 114 and at least one oxidant outlet 116, as shown in FIGS 3, 4 and 5.

[0021] A housing 118 surrounds the fuel cell 112 and bounds an insulation layer 120 that is positioned between the housing 118 and the fuel cell 112. Typically, insulation layer 120 comprises a rigid refractory material, such as a ceramic.

[0022] The insulation layer 120 defines an array of channels 122. A respective channel 122 within the array is matingly positioned adjacent to at least one respective inlet 114 for channeling oxidant flow to that respective inlet 114 from an oxidant supply feed 124. The typical arrangement comprises a respective channel 122 positioned adjacent to a respective inlet 114, however, this is not a limitation of this invention. In fact, other configurations contemplated by this invention include a single channel 122 channeling oxidant flow to multiple inlets 114 and multiple channels 122 channeling oxidant flow to a single inlet 114.

[0023] In another embodiment of the invention, a fuel distribution system 210 for a fuel cell assembly comprises a fuel cell 212, such as a solid oxide fuel cell, having at least

one fuel inlet 214 and at least one fuel outlet 216, as shown in FIG. 6. A housing 218 surrounds the fuel cell 212 and bounds an insulation layer 220 that is positioned between the housing 218 and the fuel cell 212. Typically, insulation layer 220 comprises a rigid refractory material, such as a ceramic.

[0024] The insulation layer 220 defines at least a first cavity 222 adjacent to the at least one fuel inlet 214 for channeling fuel flow to the at least one fuel inlet 214 from a fuel supply feed 224.

[0025] While typical embodiments have been set forth for the purpose of illustration, the foregoing description should not be deemed to be a limitation on the scope of the invention. For example, while hybrid systems are depicted, simple systems are also encompassed within this invention. Accordingly, various modifications, adaptations, and alternatives may occur to one skilled in the art without departing from the spirit and scope of the present invention.